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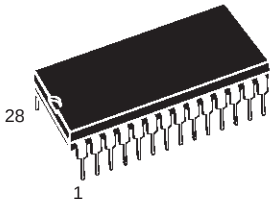
M28C64

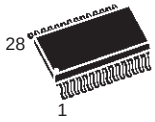
64 Kbit (8K x 8) Parallel EEPROM With Software Data Protection

- Fast Access Time:
  - 90 ns at V_{CC}=5 V for M28C64 and M28C64-A
  - 120 ns at V_{CC}=3 V for M28C64-xxW
- Single Supply Voltage:
  - 4.5 V to 5.5 V for M28C64 and M28C64-A
  - 2.7 V to 3.6 V for M28C64-xxW
- Low Power Consumption
- Fast BYTE and PAGE WRITE (up to 64 Bytes)
  - 1 ms at V_{CC}=4.5 V for M28C64-A
  - 3 ms at V_{CC}=4.5 V for M28C64
  - 5 ms at V_{CC}=2.7 V for M28C64-xxW
- Enhanced Write Detection and Monitoring:
  - Ready/$\overline{\text{Busy}}$ Open Drain Output
  - Data Polling
  - Toggle Bit
  - Page Load Timer Status
- JEDEC Approved Bytewide Pin-Out
- Software Data Protection
- 100000 Erase/Write Cycles (minimum)
- Data Retention (minimum):
  - 40 Years for M28C64 and M28C64-xxW
  - 10 Years for M28C64-A



PDIP28 (BS)

PLCC32 (KA)



SO28 (MS)
300 mil width

TSOP28 (NS)
8 x 13.4 mm

Figure 1. Logic Diagram

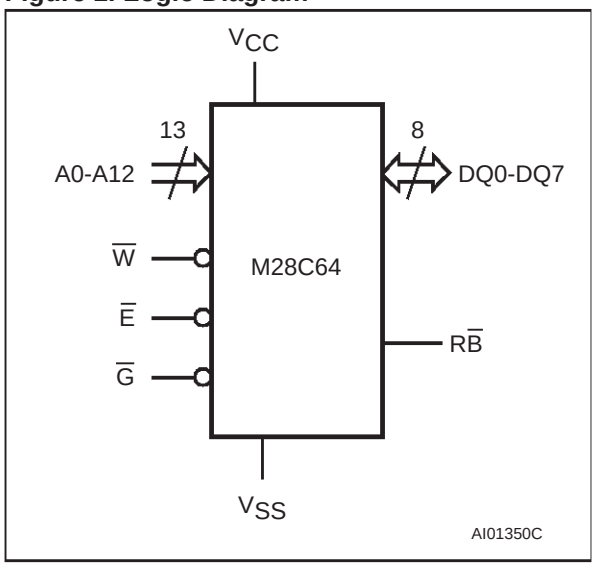
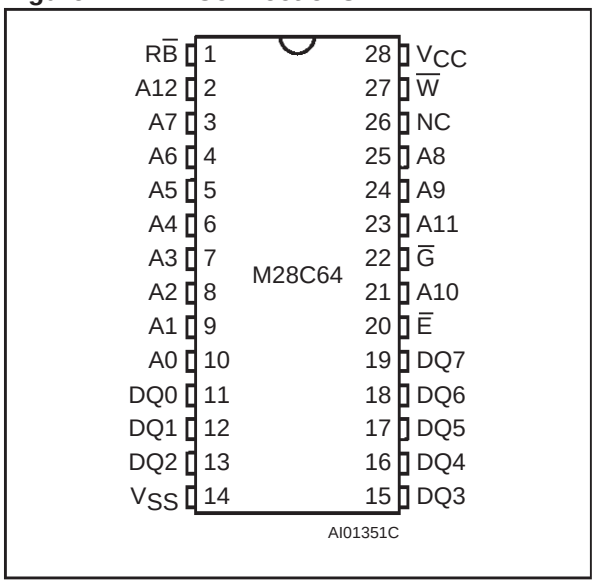


Table 1. Signal Names

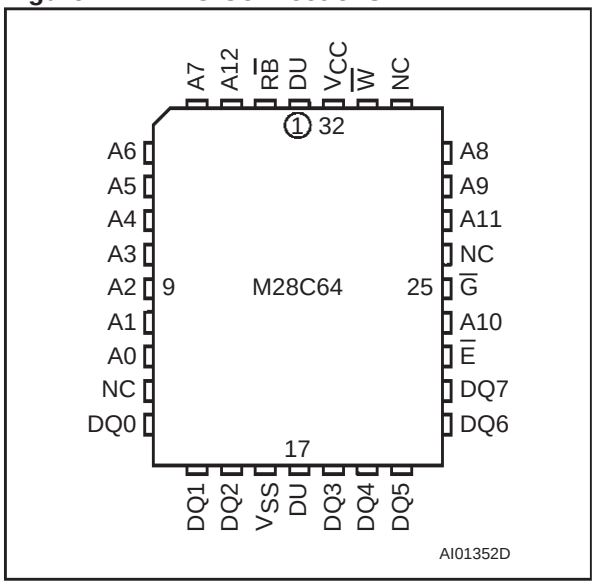
A0-A12	Address Input
DQ0-DQ7	Data Input / Output
$\overline{W}$	Write Enable
$\overline{E}$	Chip Enable
$\overline{G}$	Output Enable
$R\overline{B}$	Ready / Busy
V_{CC}	Supply Voltage
V_{SS}	Ground

Figure 2A. DIP Connections



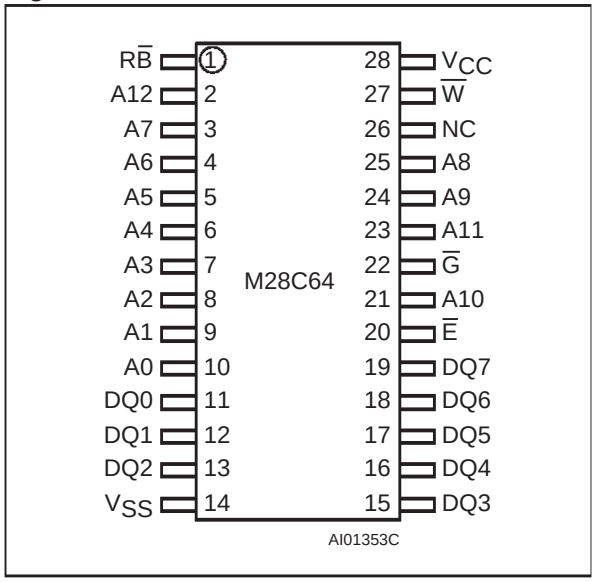
Note: 1. NC = Not Connected

Figure 2B. PLLC Connections



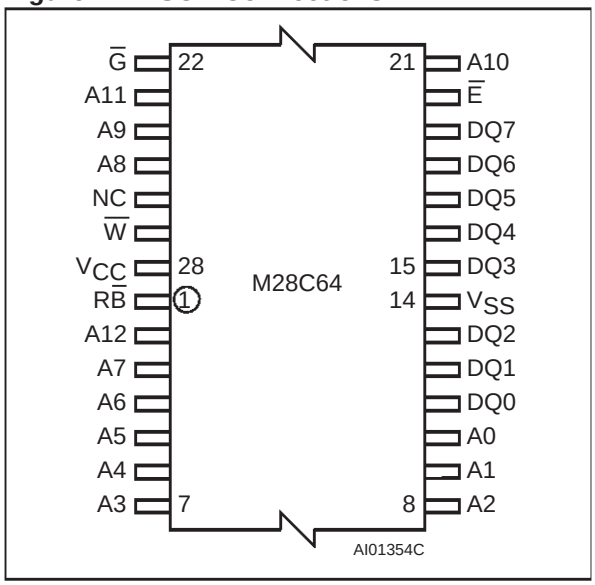
Note: 1. NC = Not Connected
2. DU = Do Not Use

Figure 2C. SO Connections



Note: 1. NC = Not Connected

Figure 2D. TSOP Connections



Note: 1. NC = Not Connected

DESCRIPTION

The M28C64 devices consist of 8192x8 bits of low power, parallel EEPROM, fabricated with STMicroelectronics' proprietary single polysilicon CMOS technology. The devices offer fast access time, with low power dissipation, and require a single voltage supply (5V or 3V, depending on the option chosen).

The device has been designed to offer a flexible microcontroller interface, featuring both hardware and software handshaking, with Ready/$\overline{\text{Busy}}$, Data Polling and Toggle Bit. The device supports a 64 byte Page Write operation. Software Data Protection (SDP) is also supported, using the standard JEDEC algorithm.

Table 2. Absolute Maximum Ratings [1]

Symbol	Parameter	Value	Unit
T_A	Ambient Operating Temperature	-40 to 125	°C
T_{STG}	Storage Temperature	-65 to 150	°C
V_{CC}	Supply Voltage	-0.3 to V_{CC}+1	V
V_{IO}	Input or Output Voltage	-0.6 to V_{CC}+0.6	V
V_I	Input Voltage	-0.3 to 6.5	V
V_{ESD}	Electrostatic Discharge Voltage (Human Body model) [2]	4000	V

Note: 1. Except for the rating "Operating Temperature Range", stresses above those listed in the Table "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the ST SURE Program and other relevant quality documents.
2. MIL-STD-883C, 3015.7 (100 pF, 1500 Ω)

Figure 3. Block Diagram

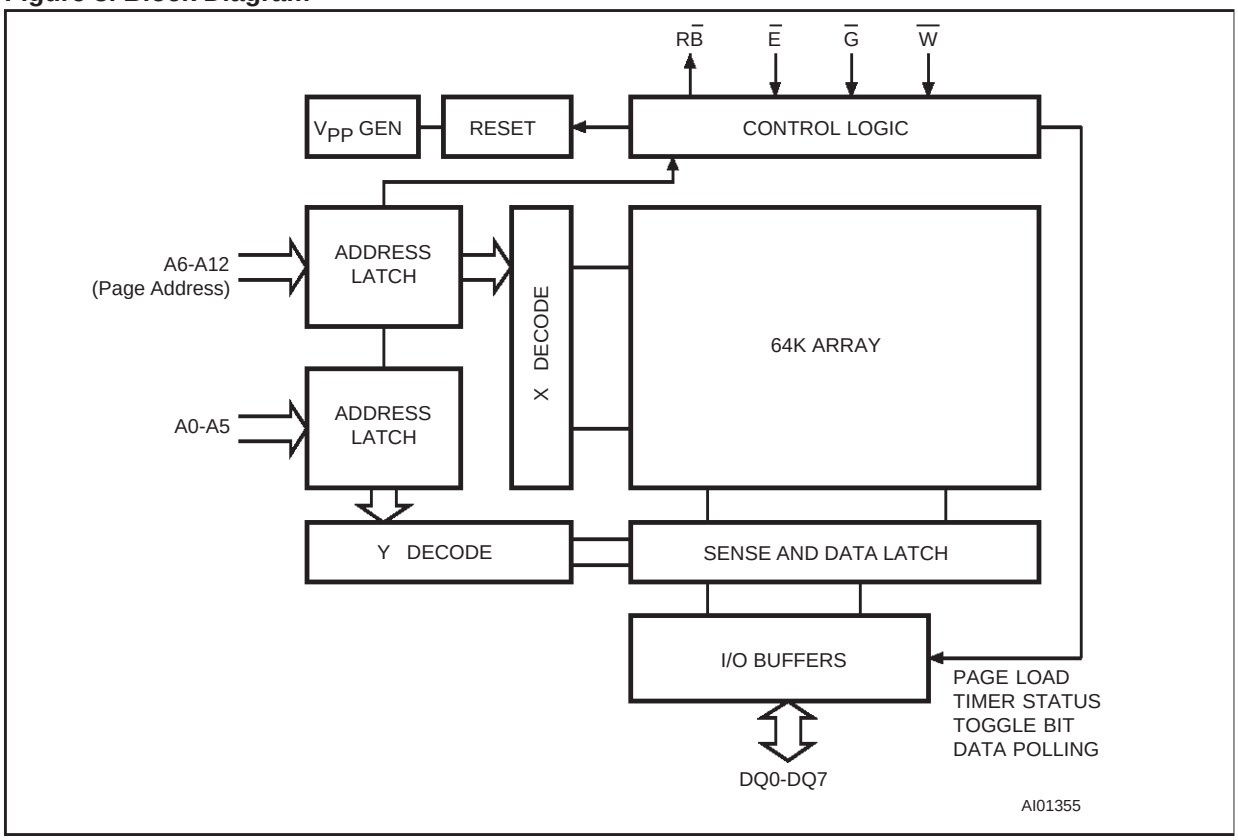


Table 3. Operating Modes [1]

Mode	$\overline{E}$	$\overline{G}$	$\overline{W}$	DQ0-DQ7
Stand-by	1	X	X	Hi-Z
Output Disable	X	1	X	Hi-Z
Write Disable	X	X	1	Hi-Z
Read	0	0	1	Data Out
Write	0	1	0	Data In
Chip Erase	0	V	0	Hi-Z

Note: 1. 0=V_{IL}; 1=V_{IH}; X = V_{IH} or V_{IL}; V=12V ± 5%.

SIGNAL DESCRIPTION

The external connections to the device are summarized in Table 1, and their use in Table 3.

Addresses (A0-A12). The address inputs are used to select one byte from the memory array during a read or write operation.

Data In/Out (DQ0-DQ7). The contents of the data byte are written to, or read from, the memory array through the Data I/O pins.

Chip Enable ($\overline{E}$). The chip enable input must be held low to enable read and write operations. When Chip Enable is high, power consumption is reduced.

Output Enable ($\overline{G}$). The Output Enable input controls the data output buffers, and is used to initiate read operations.

Write Enable ($\overline{W}$). The Write Enable input controls whether the addressed location is to be read, from or written to.

Ready/$\overline{Busy}$ ($R\overline{B}$). Ready/$\overline{Busy}$ is an open drain output that can be used to detect the end of the internal write cycle.

DEVICE OPERATION

In order to prevent data corruption and inadvertent write operations, an internal V_{CC} comparator inhibits the Write operations if the V_{CC} voltage is lower than V_{WI} (see Table 4A and Table 4B). Once the voltage applied on the V_{CC} pin goes over the V_{WI} threshold (V_{CC}>V_{WI}), write access to the memory is allowed after a time-out t_{PUW}, as specified in Table 4A and Table 4B.

Further protection against data corruption is offered by the $\overline{E}$ and $\overline{W}$ low pass filters: any glitch, on the $\overline{E}$ and $\overline{W}$ inputs, with a pulse width less than 10 ns (typical) is internally filtered out to prevent inadvertent write operations to the memory.

Table 4A. Power-Up Timing[1] for M28C64 (5V range)
(T_A = 0 to 70 °C or –40 to 85 °C or –40 to 125 °C; V_{CC} = 4.5 to 5.5 V)

Symbol	Parameter	Min.	Max.	Unit
t_{PUR}	Time Delay to Read Operation		1	µs
t_{PUW}	Time Delay to Write Operation (once $V_{CC} \geq V_{WI}$)		10	ms
V_{WI}	Write Inhibit Threshold	3.0	4.2	V

Note: 1. Sampled only, not 100% tested.

Table 4B. Power-Up Timing[1] for M28C64-xxW (3V range)
(T_A = 0 to 70 °C or –40 to 85 °C; V_{CC} = 2.7 to 3.6 V)

Symbol	Parameter	Min.	Max.	Unit
t_{PUR}	Time Delay to Read Operation		1	µs
t_{PUW}	Time Delay to Write Operation (once $V_{CC} \geq V_{WI}$)		15	ms
V_{WI}	Write Inhibit Threshold	1.5	2.5	V

Note: 1. Sampled only, not 100% tested.

Read

The device is accessed like a static RAM. When $\overline{E}$ and $\overline{G}$ are low, and $\overline{W}$ is high, the contents of the addressed location are presented on the I/O pins. Otherwise, when either $\overline{G}$ or $\overline{E}$ is high, the I/O pins revert to their high impedance state.

Write

Write operations are initiated when both $\overline{W}$ and $\overline{E}$ are low and $\overline{G}$ is high. The device supports both $\overline{W}$-controlled and $\overline{E}$-controlled write cycles (as shown in Figure 11 and Figure 12). The address is latched during the falling edge of $\overline{W}$ or $\overline{E}$ (which ever occurs later) and the data is latched on the rising edge of $\overline{W}$ or $\overline{E}$ (which ever occurs first). After a delay, t_{WLQ5H}, that cannot be shorter than the value specified in Table 10A to Table 10C, the internal write cycle starts. It continues, under internal timing control, until the write operation is complete. The commencement of this period can be detected by reading the Page Load Timer Status on DQ5. The end of the cycle can be detected by reading the status of the Data Polling and the Toggle Bit functions on DQ7 and DQ6.

Page Write

The Page Write mode allows up to 64 bytes to be written on a single page in a single go. This is achieved through a series of successive Write operations, no two of which are separated by more than the t_{WLQ5H} value (as specified in Table 10A to Table 10C).

All bytes must be located on the same page address (A12-A6 must be the same for all bytes).

The internal write cycle can start at any instant after t_{WLQ5H}. Once initiated, the write operation is internally timed, and continues, uninterrupted, until completion.

As with the single byte Write operation, described above, the DQ5, DQ6 and DQ7 lines can be used to detect the beginning and end of the internally controlled phase of the Page Write cycle.

Software Data Protection (SDP)

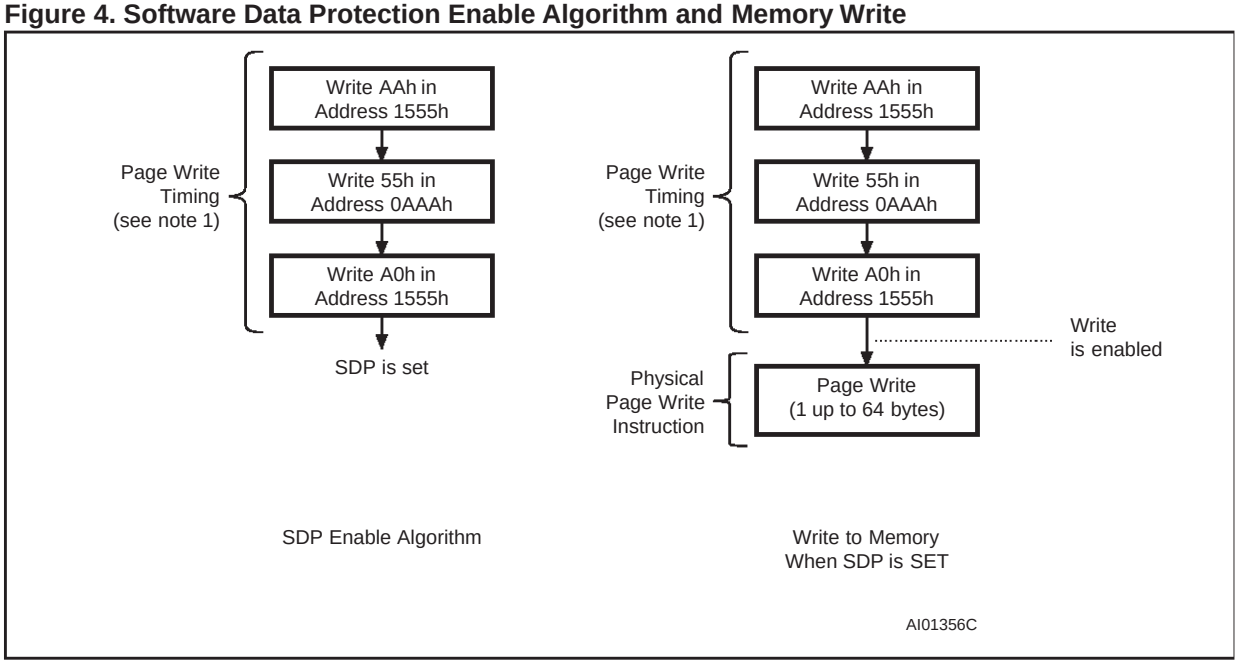
The device offers a software-controlled write-protection mechanism that allows the user to inhibit all write operations to the device. This can be useful for protecting the memory from inadvertent write cycles that may occur during periods of instability (uncontrolled bus conditions when excessive noise is detected, or when power supply levels are outside their specified values).

By default, the device is shipped in the “unprotected” state: the memory contents can be freely changed by the user. Once the Software Data Protection Mode is enabled, all write commands are ignored, and have no effect on the memory contents.

The device remains in this mode until a valid Software Data Protection disable sequence is received. The device reverts to its “unprotected” state.

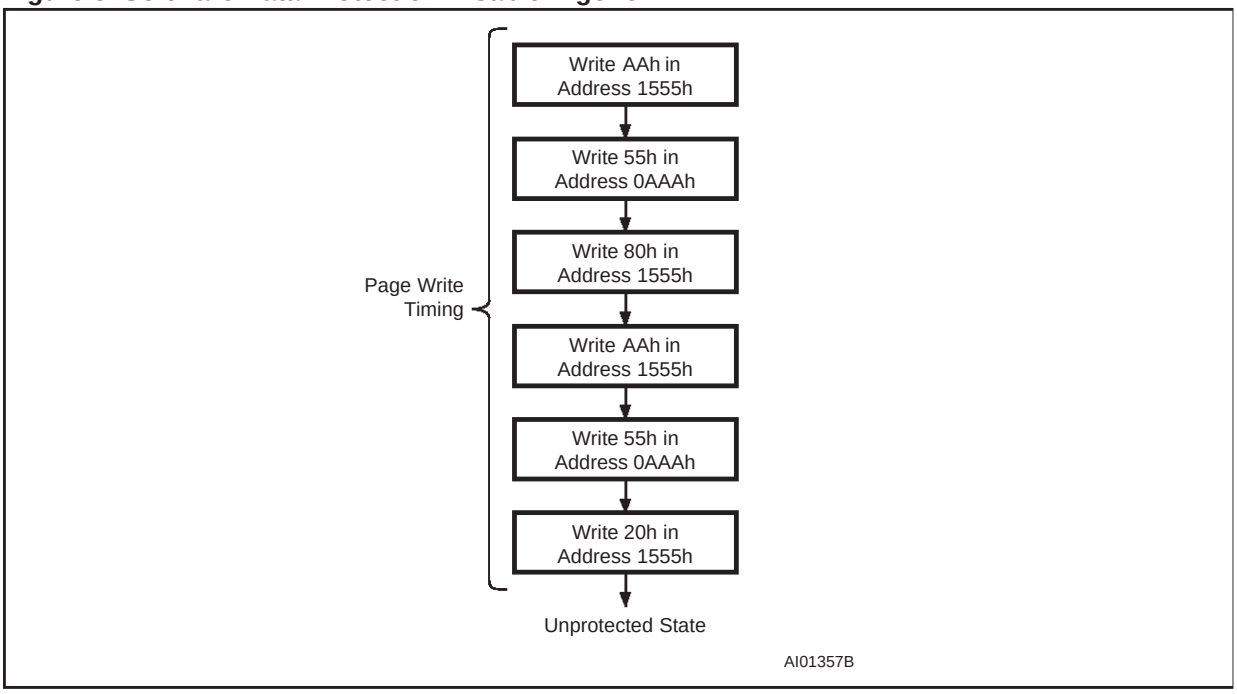
The status of the Software Data Protection (enabled or disabled) is represented by a non-

Figure 4. Software Data Protection Enable Algorithm and Memory Write


Write AAh in Address 1555h
Write 55h in Address 0AAAh
Write A0h in Address 1555h
Page Write Timing (see note 1)
SDP is set
SDP Enable Algorithm
Write AAh in Address 1555h
Write 55h in Address 0AAAh
Write A0h in Address 1555h
Page Write Timing (see note 1)
Write is enabled
Physical Page Write Instruction
Page Write (1 up to 64 bytes)
Write to Memory When SDP is SET
AI01356C

Note: 1. The most significant address bits (A12 to A6) differ during these specific Page Write operations.

Figure 5. Software Data Protection Disable Algorithm


Write AAh in Address 1555h
Write 55h in Address 0AAAh
Write 80h in Address 1555h
Page Write Timing
Write AAh in Address 1555h
Write 55h in Address 0AAAh
Write 20h in Address 1555h
Unprotected State
AI01357B

volatile latch, and is remembered across periods of the power being off.

The Software Data Protection Enable command consists of the writing of three specific data bytes to three specific memory locations (each location being on a different page), as shown in Figure 4.

Similarly to disable the Software Data Protection, the user has to write specific data bytes into six different locations, as shown in Figure 5. This complex series of operations protects against the chance of inadvertent enabling or disabling of the Software Data Protection mechanism.

When SDP is enabled, the memory array can still have data written to it, but the sequence is more complex (and hence better protected from inadvertent use). The sequence is as shown in Figure 4. This consists of an unlock key, to enable the write action, at the end of which the SDP continues to be enabled. This allows the SDP to be enabled, and data to be written, within a single Write cycle (t_{WC}).

Software Chip Erase

Using this function, available on the M28C64 but not on the M28C64-A or M28C64-xxW, the contents of the entire memory are erased (set to FFh) by holding Chip Enable ($\overline{E}$) low, and holding Output Enable ($\overline{G}$) at V_{CC}+7.0V. The chip is cleared when a 10 ms low pulse is applied to the Write Enable ($\overline{W}$) signal (see Figure 7 and Table 5 for details).

Status Bits

The devices provide three status bits (DQ7, DQ6 and DQ5), and one output pin ($\overline{RB}$), for use during write operations. These allow the application to use the write time latency of the device for getting on with other work. These signals are available on the I/O port bits DQ7, DQ6 and DQ5 (but only during programming cycle, once a byte or more has been latched into the memory) or continuously on the $\overline{RB}$ output pin.

Data Polling bit (DQ7). The internally timed write cycle starts after t_{WLQ5H} (defined in Table 10A to Table 10C) has elapsed since the previous byte was latched in to the memory. The value of the DQ7 bit of this last byte, is used as a signal

Figure 6. Status Bit Assignment

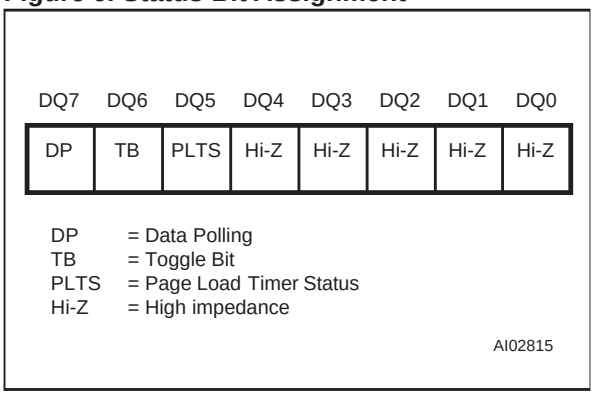
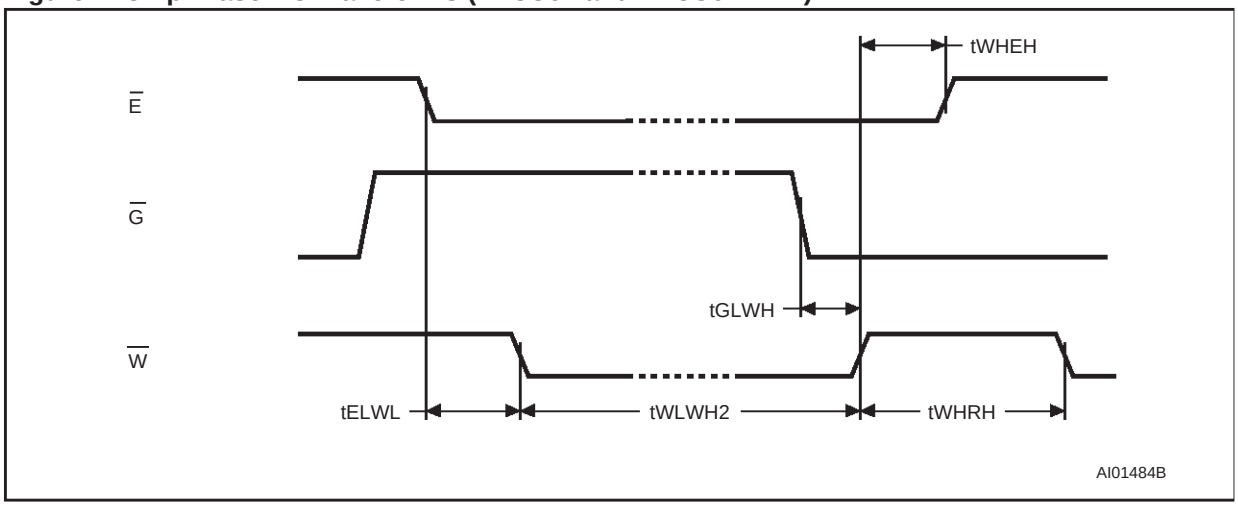

DQ7 DQ6 DQ5 DQ4 DQ3 DQ2 DQ1 DQ0
DP TB PLTS Hi-Z Hi-Z Hi-Z Hi-Z Hi-Z
DP = Data Polling
TB = Toggle Bit
PLTS = Page Load Timer Status
Hi-Z = High impedance
AI02815

Figure 7. Chip Erase AC Waveforms (M28C64 and M28C64-xxW)



throughout this write operation: it is inverted while the internal write operation is underway, and is inverted back to its original value once the operation is complete.

Toggle bit (DQ6). The device offers another way for determining when the internal write cycle is completed. During the internal Erase/Write cycle, DQ6 toggles from '0' to '1' and '1' to '0' (the first read value being '0') on subsequent attempts to read any byte of the memory. When the internal write cycle is complete, the toggling is stopped, and the values read on DQ7-DQ0 are those of the addressed memory byte. This indicates that the device is again available for new Read and Write operations.

Page Load Timer Status bit (DQ5). An internal timer is used to measure the period between successive Write operations, up to t_{WLQ5H} (defined in Table 10A to Table 10C). The DQ5 line is held low to show when this timer is running (hence showing that the device has received one write operation, and is waiting for the next). The DQ5 line is held high when the counter has overflowed (hence showing that the device is now starting the internal write to the memory array).

Ready/$\overline{\text{Busy}}$ pin. The R$\overline{\text{B}}$ pin is an open drain output that is held low during the erase/write cycle, and that is released (allowed to float) at the completion of the programming cycle.

Table 5. Chip Erase AC Characteristics[1] for M28C64 and M28C64-xxW
(T_A = 0 to 70 °C or –40 to 85 °C or –40 to 125 °C; V_{CC} = 4.5 to 5.5 V)
(T_A = 0 to 70 °C or –40 to 85 °C; V_{CC} = 2.7 to 3.6 V)

Symbol	Parameter	Test Condition	Min.	Max.	Unit
t_{ELWL}	Chip Enable Low to Write Enable Low	$\overline{G}$ = V_{CC} + 7V	1		µs
t_{WHEH}	Write Enable High to Chip Enable High	$\overline{G}$ = V_{CC} + 7V	0		ns
t_{WLWH2}	Write Enable Low to Write Enable High	$\overline{G}$ = V_{CC} + 7V	10		ms
t_{GLWH}	Output Enable Low to Write Enable High	$\overline{G}$ = V_{CC} + 7V	1		µs
t_{WHRH}	Write Enable High to Write Enable Low	$\overline{G}$ = V_{CC} + 7V		3	ms

Note: 1. Sampled only, not 100% tested.

Table 6A. Read Mode DC Characteristics for M28C64 and M28C64-A (5V range)
(T_A = 0 to 70 °C or –40 to 85 °C or –40 to 125 °C; V_{CC} = 4.5 to 5.5 V)

Symbol	Parameter	Test Condition	Min.	Max.	Unit
I_{LI}	Input Leakage Current	$0 V \le V_{IN} \le V_{CC}$		10	µA
I_{LO}	Output Leakage Current	$0 V \le V_{OUT} \le V_{CC}$		10	µA
I_{CC} [1]	Supply Current (TTL inputs)	$\overline{E} = V_{IL}$, $\overline{G} = V_{IL}$, f = 5 MHz		30	mA
	Supply Current (CMOS inputs)	$\overline{E} = V_{IL}$, $\overline{G} = V_{IL}$, f = 5 MHz		25	mA
I_{CC1} [1]	Supply Current (Stand-by) TTL	$\overline{E} = V_{IH}$		1	mA
I_{CC2} [1]	Supply Current (Stand-by) CMOS	$\overline{E} > V_{CC} - 0.3V$		100	µA
V_{IL}	Input Low Voltage		-0.3	0.8	V
V_{IH}	Input High Voltage		2	V_{CC} + 0.5	V
V_{OL}	Output Low Voltage	I_{OL} = 2.1 mA		0.4	V
V_{OH}	Output High Voltage	I_{OH} = -400 µA	2.4		V

Note: 1. All inputs and outputs open circuit.

Table 6B. Read Mode DC Characteristics for M28C64-xxW (3V range)
(T_A = 0 to 70 °C or –40 to 85 °C; V_{CC} = 2.7 to 3.6 V)

Symbol	Parameter	Test Condition	Min.	Max.	Unit
I_{LI}	Input Leakage Current	$0 V \le V_{IN} \le V_{CC}$		10	µA
I_{LO}	Output Leakage Current	$0 V \le V_{OUT} \le V_{CC}$		10	µA
I_{CC} [1]	Supply Current (CMOS inputs)	$\overline{E} = V_{IL}$, $\overline{G} = V_{IL}$, f = 5 MHz, V_{CC} = 3.3V		8	mA
		$\overline{E} = V_{IL}$, $\overline{G} = V_{IL}$, f = 5 MHz, V_{CC} = 3.6V		10	mA
I_{CC2} [1]	Supply Current (Stand-by) CMOS	$\overline{E} > V_{CC} - 0.3V$		20	µA
V_{IL}	Input Low Voltage		-0.3	0.6	V
V_{IH}	Input High Voltage		2	V_{CC} + 0.5	V
V_{OL}	Output Low Voltage	I_{OL} = 1.6 mA		0.2 V_{CC}	V
V_{OH}	Output High Voltage	I_{OH} = -400 µA	0.8 V_{CC}		V

Note: 1. All inputs and outputs open circuit.

Table 7. Input and Output Parameters[1] (T_A = 25 °C, f = 1 MHz)

Symbol	Parameter	Test Condition	Min.	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 0 V		6	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0 V		12	pF

Note: 1. Sampled only, not 100% tested.

Table 8. AC Measurement Conditions

Input Rise and Fall Times	≤ 20 ns
Input Pulse Voltages (M28C64, M28C64-A)	0.4 V to 2.4 V
Input Pulse Voltages (M28C64-xxW)	0 V to V_{CC}-0.3V
Input and Output Timing Reference Voltages (M28C64, M28C64-A)	0.8 V to 2.0 V
Input and Output Timing Reference Voltages (M28C64-xxW)	0.5 V_{CC}

Figure 8. AC Testing Input Output Waveforms

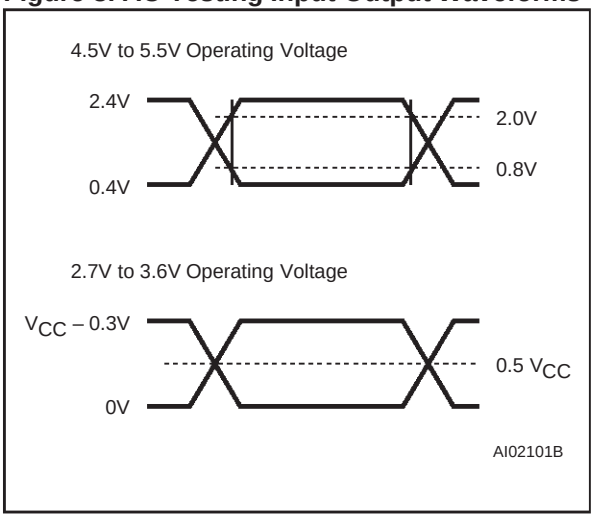


Figure 9. AC Testing Equivalent Load Circuit

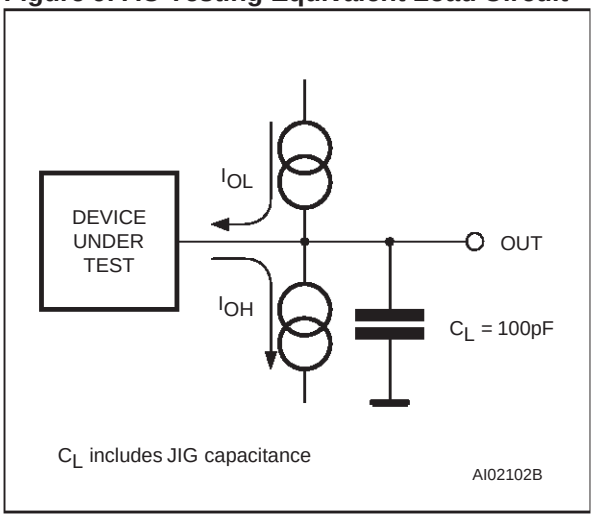


Table 9A. Read Mode AC Characteristics for M28C64 and M28C64-A (5V range)
(T_A = 0 to 70 °C or –40 to 85 °C; V_{CC} = 4.5 to 5.5 V)

Symbol	Alt.	Parameter	Test Condition	M28C64						Unit
				-90		-12		-15		
				Min	Max	Min	Max	Min	Max	
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		90		120		150	ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		90		120		150	ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		40		45		50	ns
t_{EHQZ}[1]	t_{DF}	Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}	0	40	0	45	0	50	ns
t_{GHQZ}[1]	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}	0	40	0	45	0	50	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		0		0		ns

Note: 1. Output Hi-Z is defined as the point at which data is no longer driven.

Table 9B. Read Mode AC Characteristics for M28C64 (5V range)
(T_A = –40 to 125 °C; V_{CC} = 4.5 to 5.5 V)

Symbol	Alt.	Parameter	Test Condition	M28C64		Unit
				-12		
				Min	Max	
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		120	ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		120	ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		45	ns
t_{EHQZ}[1]	t_{DF}	Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}	0	65	ns
t_{GHQZ}[1]	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}	0	65	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		ns

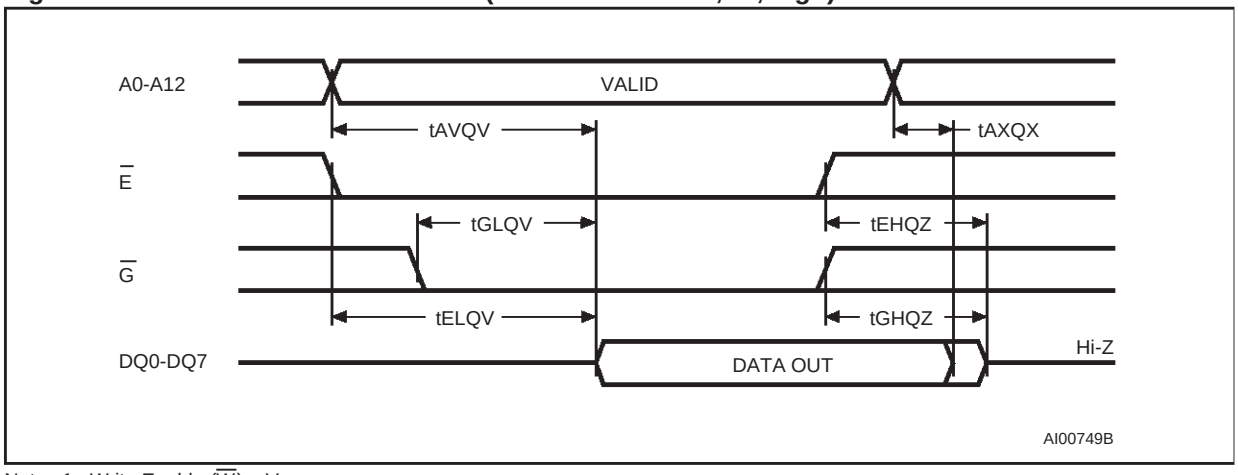
Note: 1. Output Hi-Z is defined as the point at which data is no longer driven.

Table 9C. Read Mode AC Characteristics for M28C64-xxW (3V range)
(T_A = 0 to 70 °C or –40 to 85 °C; V_{CC} = 2.7 to 3.6 V)

Symbol	Alt.	Parameter	Test Condition	M28C64-xxW										Unit
				-12		-15		-20		-25		-30		
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
t_{AVQV}	t_{ACC}	Address Valid to Output Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}		120		150		200		250		300	ns
t_{ELQV}	t_{CE}	Chip Enable Low to Output Valid	$\overline{G}$ = V_{IL}		120		150		200		250		300	ns
t_{GLQV}	t_{OE}	Output Enable Low to Output Valid	$\overline{E}$ = V_{IL}		80		80		100		150		150	ns
t_{EHQZ}[1]	t_{DF}	Chip Enable High to Output Hi-Z	$\overline{G}$ = V_{IL}	0	45	0	50	0	55	0	60	0	60	ns
t_{GHQZ}[1]	t_{DF}	Output Enable High to Output Hi-Z	$\overline{E}$ = V_{IL}	0	45	0	50	0	55	0	60	0	60	ns
t_{AXQX}	t_{OH}	Address Transition to Output Transition	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IL}	0		0		0		0		0		ns

Note: 1. Output Hi-Z is defined as the point at which data is no longer driven.

Figure 10. Read Mode AC Waveforms (with Write Enable, $\overline{W}$, high)



Note: 1. Write Enable ($\overline{W}$) = V_{IH}

Table 10A. Write Mode AC Characteristics for M28C64 and M28C64-A (5V range)
(T_A = 0 to 70 °C or –40 to 85 °C; V_{CC} = 4.5 to 5.5 V)

Symbol	Alt.	Parameter	Test Condition	M28C64		Unit
				Min	Max	
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IH}	0		ns
t_{AVEL}	t_{AS}	Address Valid to Chip Enable Low	$\overline{G}$ = V_{IH}, $\overline{W}$ = V_{IL}	0		ns
t_{ELWL}	t_{CES}	Chip Enable Low to Write Enable Low	$\overline{G}$ = V_{IH}	0		ns
t_{GHWL}	t_{OES}	Output Enable High to Write Enable Low	$\overline{E}$ = V_{IL}	0		ns
t_{GHEL}	t_{OES}	Output Enable High to Chip Enable Low	$\overline{W}$ = V_{IL}	0		ns
t_{WLEL}	t_{WES}	Write Enable Low to Chip Enable Low	$\overline{G}$ = V_{IH}	0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition		50		ns
t_{ELAX}	t_{AH}	Chip Enable Low to Address Transition		50		ns
t_{WLDV}	t_{DV}	Write Enable Low to Input Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IH}		1	µs
t_{ELDV}	t_{DV}	Chip Enable Low to Input Valid	$\overline{G}$ = V_{IH}, $\overline{W}$ = V_{IL}		1	µs
t_{ELEH}	t_{WP}	Chip Enable Low to Chip Enable High		50		ns
t_{WHEH}	t_{CEH}	Write Enable High to Chip Enable High		0		ns
t_{WHGL}	t_{OEH}	Write Enable High to Output Enable Low		0		ns
t_{EHGL}	t_{OEH}	Chip Enable High to Output Enable Low		0		ns
t_{EHWH}	t_{WEH}	Chip Enable High to Write Enable High		0		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition		0		ns
t_{EHDX}	t_{DH}	Chip Enable High to Input Transition		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low		50	1000	ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High		50		ns
t_{WLQ5H}	t_{BLC}	Time-out after last byte write (M28C64)		100		µs
		Time-out after last byte write (M28C64-A)		20		µs
t_{Q5HQ5X}	t_{WC}	Write Cycle Time (M28C64)			3	ms
		Write Cycle Time (M28C64-A)			1	ms
t_{WHRL}	t_{DB}	Write Enable High to Ready/Busy Low	Note 1		150	ns
t_{EHRL}	t_{DB}	Chip Enable High to Ready/Busy Low	Note 1		150	ns
t_{DVWH}	t_{DS}	Data Valid before Write Enable High		50		ns
t_{DVEH}	t_{DS}	Data Valid before Chip Enable High		50		ns

Note: 1. With a 3.3 kΩ pull-up resistor.

Table 10B. Write Mode AC Characteristics for M28C64 (5V range)
(T_A = –40 to 125 °C; V_{CC} = 4.5 to 5.5 V)

Symbol	Alt.	Parameter	Test Condition	M28C64		Unit
				Min	Max	
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IH}	0		ns
t_{AVEL}	t_{AS}	Address Valid to Chip Enable Low	$\overline{G}$ = V_{IH}, $\overline{W}$ = V_{IL}	0		ns
t_{ELWL}	t_{CES}	Chip Enable Low to Write Enable Low	$\overline{G}$ = V_{IH}	0		ns
t_{GHWL}	t_{OES}	Output Enable High to Write Enable Low	$\overline{E}$ = V_{IL}	0		ns
t_{GHEL}	t_{OES}	Output Enable High to Chip Enable Low	$\overline{W}$ = V_{IL}	0		ns
t_{WLEL}	t_{WES}	Write Enable Low to Chip Enable Low	$\overline{G}$ = V_{IH}	0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition		75		ns
t_{ELAX}	t_{AH}	Chip Enable Low to Address Transition		75		ns
t_{WLDV}	t_{DV}	Write Enable Low to Input Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IH}		1	µs
t_{ELDV}	t_{DV}	Chip Enable Low to Input Valid	$\overline{G}$ = V_{IH}, $\overline{W}$ = V_{IL}		1	µs
t_{ELEH}	t_{WP}	Chip Enable Low to Chip Enable High		50		ns
t_{WHEH}	t_{CEH}	Write Enable High to Chip Enable High		0		ns
t_{WHGL}	t_{OEH}	Write Enable High to Output Enable Low		0		ns
t_{EHGL}	t_{OEH}	Chip Enable High to Output Enable Low		0		ns
t_{EHWH}	t_{WEH}	Chip Enable High to Write Enable High		0		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition		0		ns
t_{EHDX}	t_{DH}	Chip Enable High to Input Transition		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low		50	1000	ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High		50		ns
t_{WLQ5H}	t_{BLC}	Time-out after last byte write (M28C64)		100		µs
		Time-out after last byte write (M28C64-A)		20		µs
t_{Q5HQ5X}	t_{WC}	Write Cycle Time (M28C64)			3	ms
		Write Cycle Time (M28C64-A)			1	ms
t_{WHRL}	t_{DB}	Write Enable High to Ready/Busy Low	Note 1		150	ns
t_{EHRL}	t_{DB}	Chip Enable High to Ready/Busy Low	Note 1		150	ns
t_{DVWH}	t_{DS}	Data Valid before Write Enable High		50		ns
t_{DVEH}	t_{DS}	Data Valid before Chip Enable High		50		ns

Table 10C. Write Mode AC Characteristics for M28C64-xxW (3V range)
(T_A = 0 to 70 °C or –40 to 85 °C; V_{CC} = 2.7 to 3.6 V)

Symbol	Alt.	Parameter	Test Condition	M28C64-xxW		Unit
				Min	Max	
t_{AVWL}	t_{AS}	Address Valid to Write Enable Low	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IH}	0		ns
t_{AVEL}	t_{AS}	Address Valid to Chip Enable Low	$\overline{G}$ = V_{IH}, $\overline{W}$ = V_{IL}	0		ns
t_{ELWL}	t_{CES}	Chip Enable Low to Write Enable Low	$\overline{G}$ = V_{IH}	0		ns
t_{GHWL}	t_{OES}	Output Enable High to Write Enable Low	$\overline{E}$ = V_{IL}	0		ns
t_{GHEL}	t_{OES}	Output Enable High to Chip Enable Low	$\overline{W}$ = V_{IL}	0		ns
t_{WLEL}	t_{WES}	Write Enable Low to Chip Enable Low	$\overline{G}$ = V_{IH}	0		ns
t_{WLAX}	t_{AH}	Write Enable Low to Address Transition		100		ns
t_{ELAX}	t_{AH}	Chip Enable Low to Address Transition		100		ns
t_{WLDV}	t_{DV}	Write Enable Low to Input Valid	$\overline{E}$ = V_{IL}, $\overline{G}$ = V_{IH}		1	µs
t_{ELDV}	t_{DV}	Chip Enable Low to Input Valid	$\overline{G}$ = V_{IH}, $\overline{W}$ = V_{IL}		1	µs
t_{ELEH}	t_{WP}	Chip Enable Low to Chip Enable High		100	1000	ns
t_{WHEH}	t_{CEH}	Write Enable High to Chip Enable High		0		ns
t_{WHGL}	t_{OEH}	Write Enable High to Output Enable Low		0		ns
t_{EHGL}	t_{OEH}	Chip Enable High to Output Enable Low		0		ns
t_{EHWH}	t_{WEH}	Chip Enable High to Write Enable High		0		ns
t_{WHDX}	t_{DH}	Write Enable High to Input Transition		0		ns
t_{EHDX}	t_{DH}	Chip Enable High to Input Transition		0		ns
t_{WHWL}	t_{WPH}	Write Enable High to Write Enable Low		50	1000	ns
t_{WLWH}	t_{WP}	Write Enable Low to Write Enable High		100		ns
t_{WLQ5H}	t_{BLC}	Time-out after the last byte write		100		µs
t_{Q5HQ5X}	t_{WC}	Write Cycle Time			5	ms
t_{WHRL}	t_{DB}	Write Enable High to Ready/Busy Low	Note 1		150	ns
t_{EHRL}	t_{DB}	Chip Enable High to Ready/Busy Low	Note 1		150	ns
t_{DVWH}	t_{DS}	Data Valid before Write Enable High		50		ns
t_{DVEH}	t_{DS}	Data Valid before Chip Enable High		50		ns

Note: 1. With a 3.3 kΩ pull-up resistor.

Figure 11. Write Mode AC Waveforms (Write Enable, $\overline{W}$, controlled)

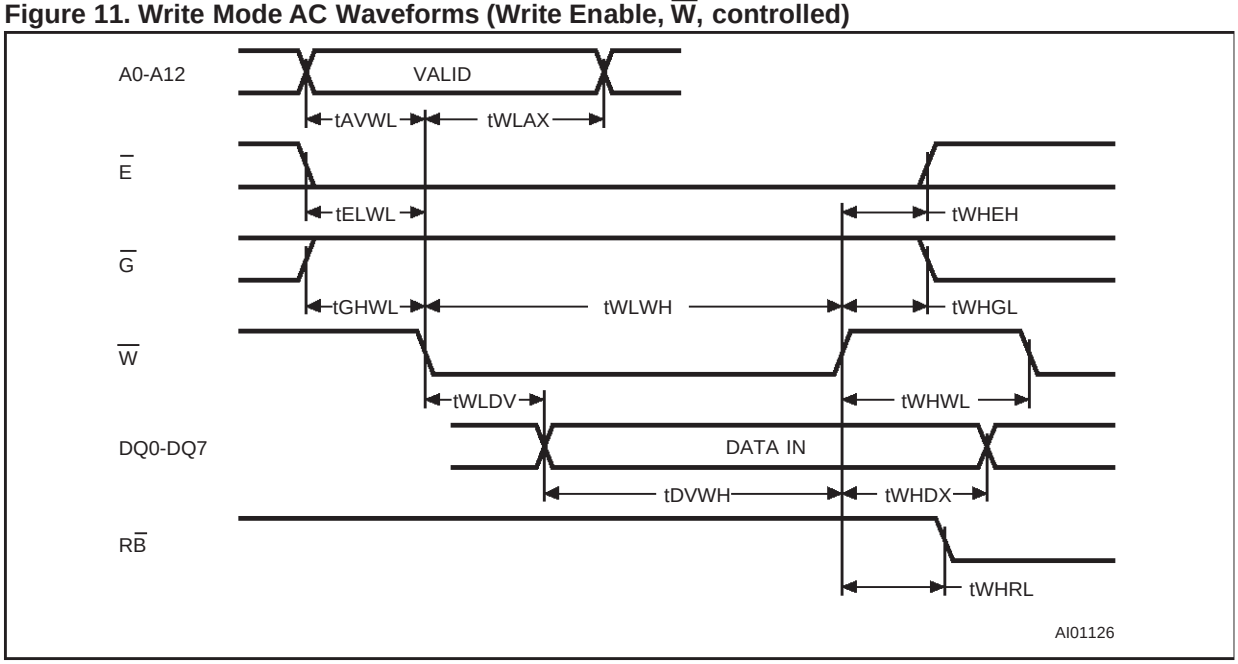


Figure 12. Write Mode AC Waveforms (Chip Enable, $\overline{E}$, controlled)

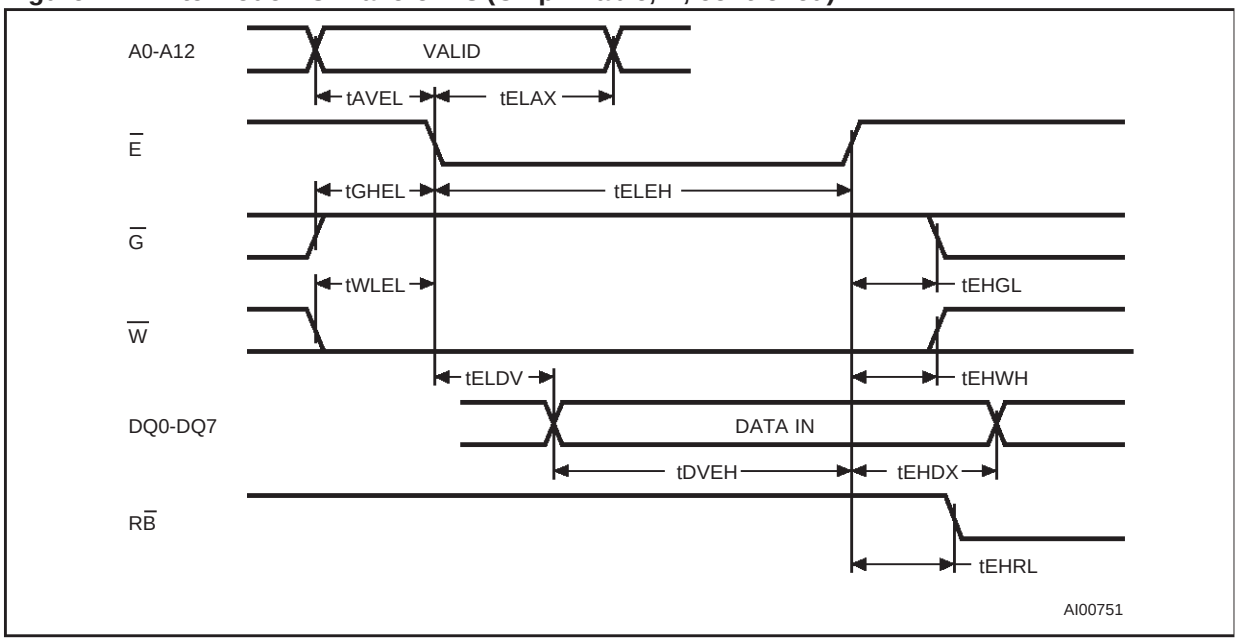


Figure 13. Page Write Mode AC Waveforms (Write Enable, $\overline{W}$, controlled)

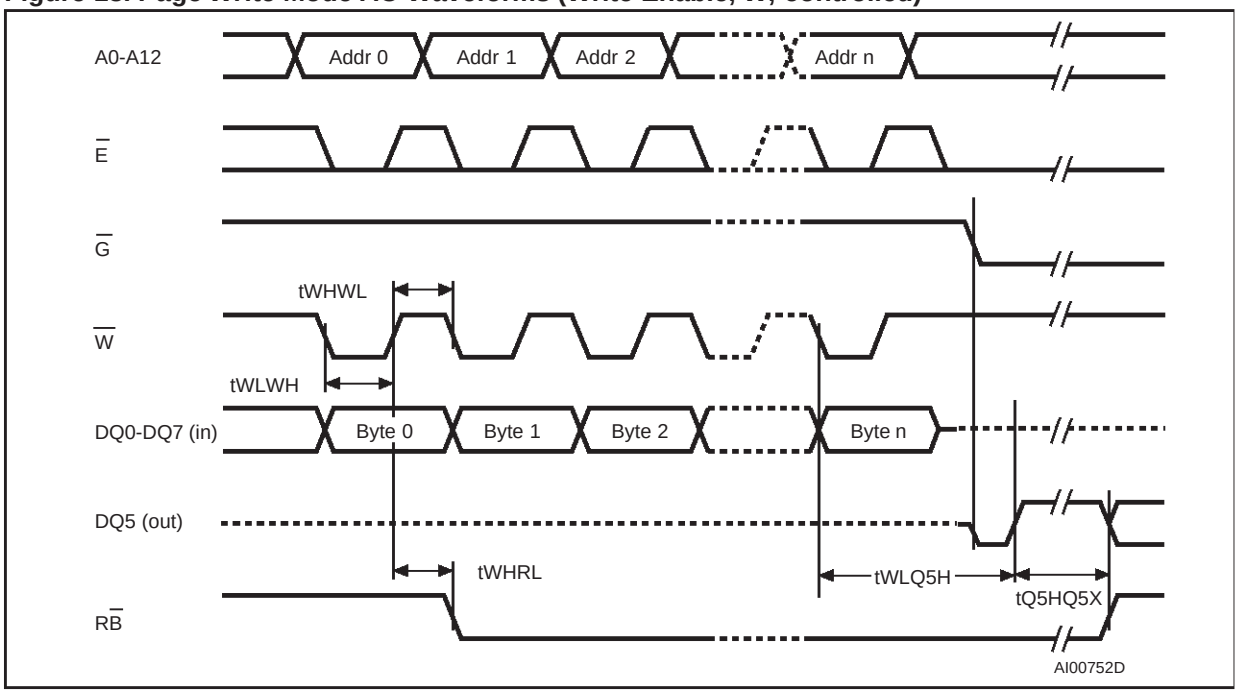
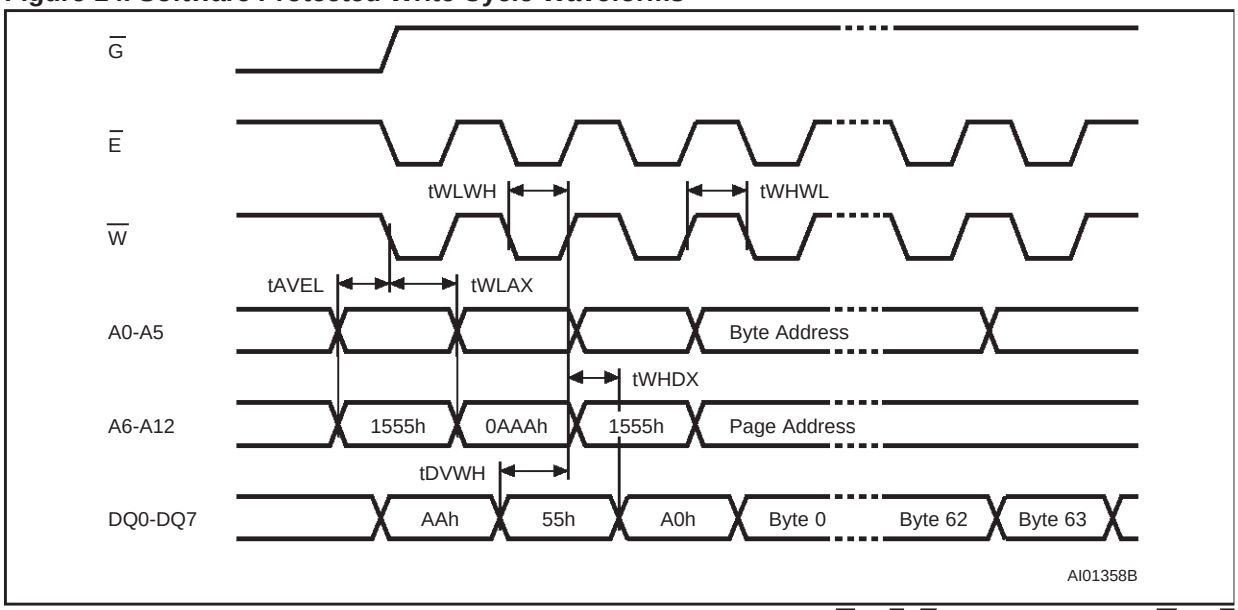


Figure 14. Software Protected Write Cycle Waveforms



Note: 1. A12 to A6 must specify the same page address during each high-to-low transition of $\overline{W}$ (or $\overline{E}$). $\overline{G}$ must be high only when $\overline{W}$ and $\overline{E}$ are both low.

Figure 15. Data Polling Sequence Waveforms

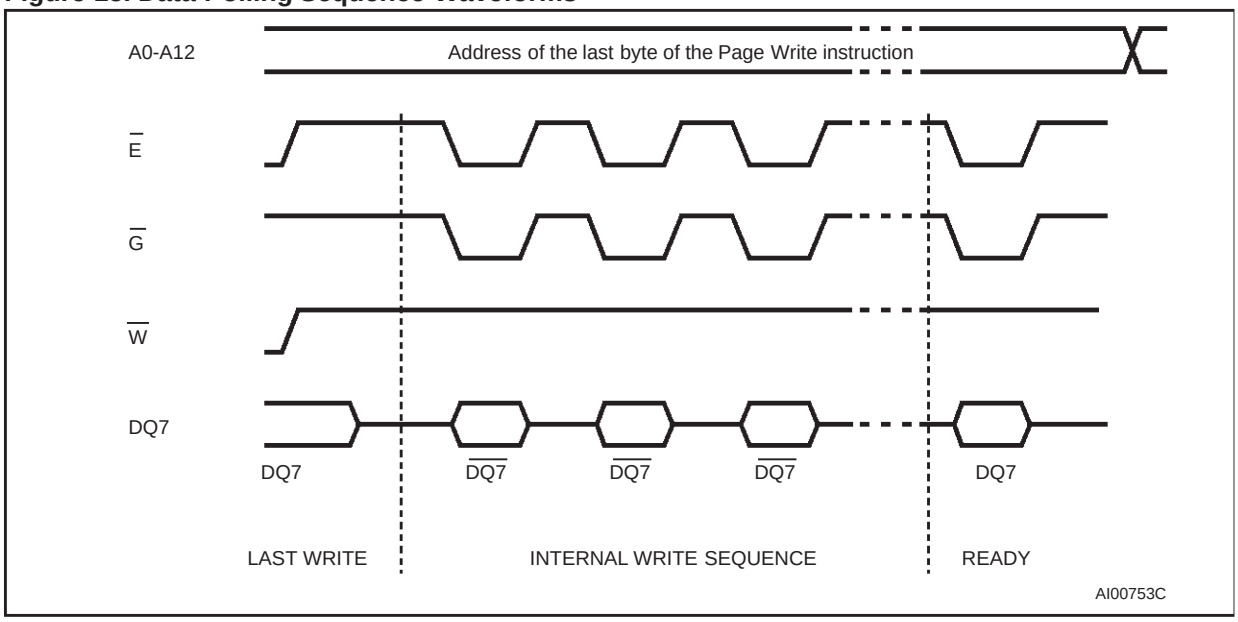
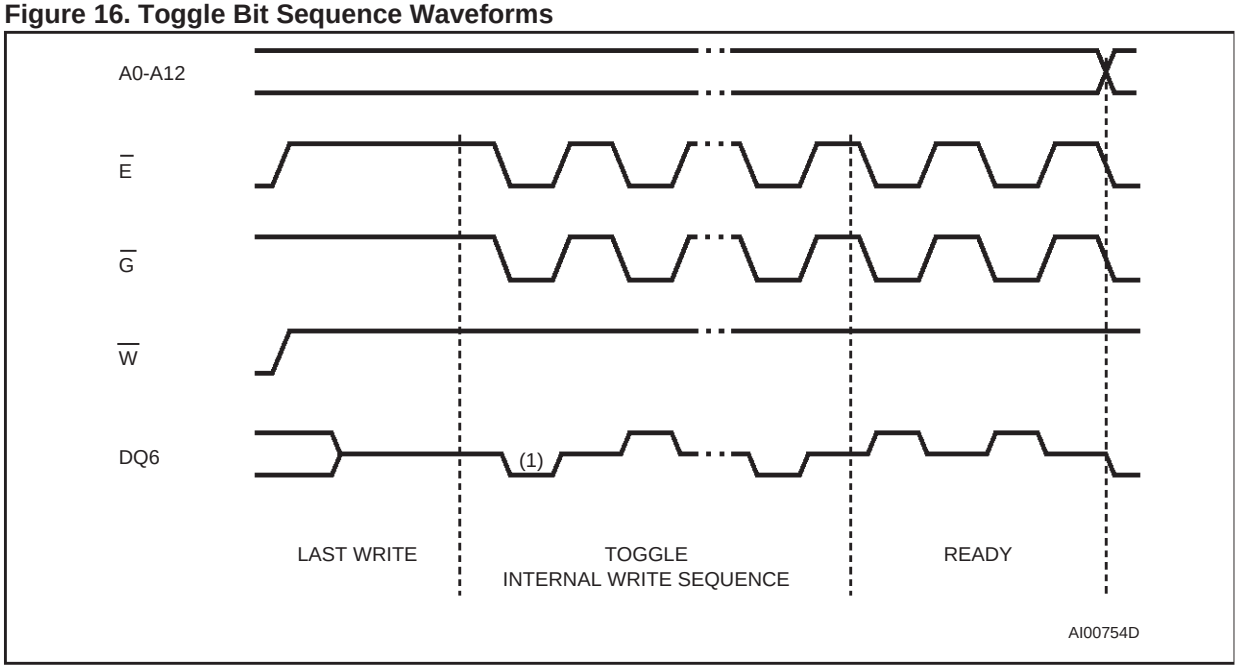


Figure 16. Toggle Bit Sequence Waveforms



Note: 1. The Toggle Bit is first set to '0'.

Table 11. Ordering Information Scheme

Example: M28C64 – A 12 BS 6 T

Write Time

blank	t_{WC} = 3 ms at 4.5V to 5.5V; t_{WC} = 5 ms at 2.7V to 3.6V
A[1]	t_{WC} = 1 ms at 4.5V to 5.5V

Speed

90[2]	90 ns
12	120 ns
15	150 ns
20[3]	200 ns
25[3]	250 ns
30[3]	300 ns

Operating Voltage

blank	4.5 V to 5.5 V
W[4]	2.7 V to 3.6 V

Option

T	Tape and Reel Packing

Temperature Range

1	0 °C to 70 °C
6	–40 °C to 85 °C
3	–40 °C to 125 °C[5]

Package

BS	PDIP28
KA	PLCC32
MS	SO28 (300 mil width)
NS	TSOP28 (8 x 13.4 mm)

Note: 1. Available only with 120 ns speed (-12), 5V operating range (-blank), and -40 to 85 °C temperature range (-6).
2. Available for the M28C64 only.
3. Available for the 3V range (-xxW) only.
4. Not available for the 1 ms write time option (-A).
5. Available only for the "M28C64 - 12 MS 3" (5V range, SO28 package)

ORDERING INFORMATION

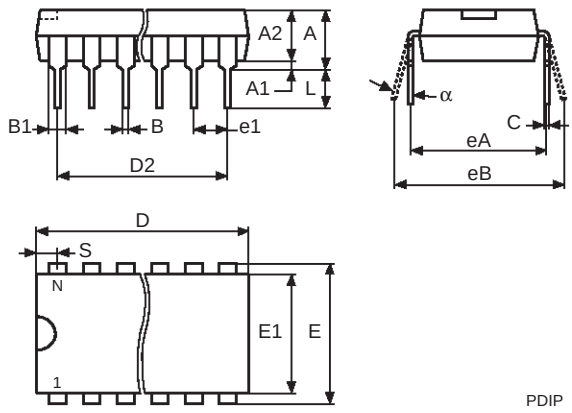
Devices are shipped from the factory with the memory content set at all '1's (FFh).

The notation used for the device number is as shown in Table 11. For a list of available options (speed, package, etc.) or for further information on any aspect of this device, please contact your nearest ST Sales Office.

Table 12. PDIP28 - 28 pin Plastic DIP, 600 mils width

Symb.	mm			inches		
	Typ.	Min.	Max.	Typ.	Min.	Max.
A		3.94	5.08		0.155	0.200
A1		0.38	1.78		0.015	0.070
A2		3.56	4.06		0.140	0.160
B		0.38	0.56		0.015	0.021
B1		1.14	1.78		0.045	0.070
C		0.20	0.30		0.008	0.012
D		34.70	37.34		1.366	1.470
E		14.80	16.26		0.583	0.640
E1		12.50	13.97		0.492	0.550
e1	2.54	–	–	0.100	–	–
eA		15.20	17.78		0.598	0.700
L		3.05	3.82		0.120	0.150
S		1.02	2.29		0.040	0.090
α		0°	15°		0°	15°
N	28			28		

Figure 17. PDIP28 (BS)

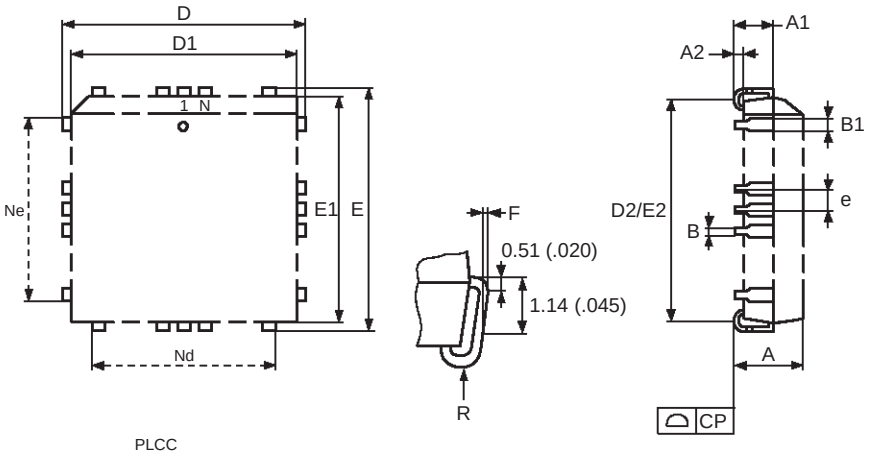


Note: 1. Drawing is not to scale.

Table 13. PLCC32 - 32 lead Plastic Leaded Chip Carrier, rectangular

Symbol	mm			inches		
	Typ.	Min.	Max.	Typ.	Min.	Max.
A		2.54	3.56		0.100	0.140
A1		1.52	2.41		0.060	0.095
A2		–	0.38		–	0.015
B		0.33	0.53		0.013	0.021
B1		0.66	0.81		0.026	0.032
D		12.32	12.57		0.485	0.495
D1		11.35	11.56		0.447	0.455
D2		9.91	10.92		0.390	0.430
E		14.86	15.11		0.585	0.595
E1		13.89	14.10		0.547	0.555
E2		12.45	13.46		0.490	0.530
e	1.27	–	–	0.050	–	–
F		0.00	0.25		0.000	0.010
R	0.89	–	–	0.035	–	–
N	32			32		
Nd	7			7		
Ne	9			9		
CP			0.10			0.004

Figure 18. PLCC (KA)

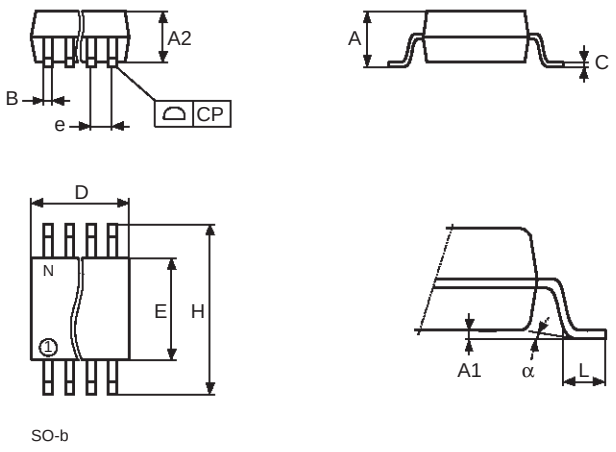


Note: 1. Drawing is not to scale.

Table 14. SO28 - 28 lead Plastic Small Outline, 300 mils body width

Symb.	mm			inches		
	Typ.	Min.	Max.	Typ.	Min.	Max.
A		2.46	2.64		0.097	0.104
A1		0.13	0.29		0.005	0.011
A2		2.29	2.39		0.090	0.094
B		0.35	0.48		0.014	0.019
C		0.23	0.32		0.009	0.013
D		17.81	18.06		0.701	0.711
E		7.42	7.59		0.292	0.299
e	1.27	–	–	0.050	–	–
H		10.16	10.41		0.400	0.410
L		0.61	1.02		0.024	0.040
α		0°	8°		0°	8°
N	28			28		
CP			0.10			0.004

Figure 19. SO28 wide (MS)



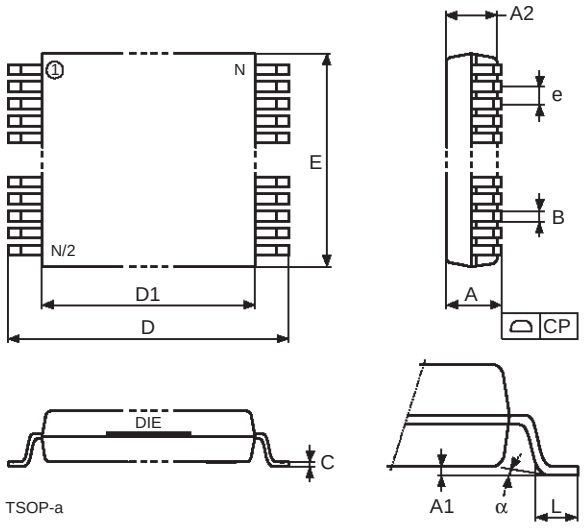
SO-b

Note: 1. Drawing is not to scale.

Table 15. TSOP28 - 28 lead Plastic Thin Small Outline, 8 x 13.4 mm

Symb.	mm			inches		
	Typ.	Min.	Max.	Typ.	Min.	Max.
A			1.25			0.049
A1			0.20			0.008
A2		0.95	1.15		0.037	0.045
B		0.17	0.27		0.007	0.011
C		0.10	0.21		0.004	0.008
D		13.20	13.60		0.520	0.535
D1		11.70	11.90		0.461	0.469
E		7.90	8.10		0.311	0.319
e	0.55	–	–	0.022	–	–
L		0.50	0.70		0.020	0.028
α		0°	5°		0°	5°
N	28			28		
CP			0.10			0.004

Figure 20. TSOP28 (NS)



Note: 1. Drawing is not to scale.

Table 16. Revision History

Date	Description of Revision
31-Mar-2000	–40 to 125°C temperature range added to timing and characteristics tables, and order info
19-Jun-2000	Paragraph on behaviour, following an out-of-bounds page write operation, corrected

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